Genetically engineered (GE) crops and foods will not help farmers improve their financial and environmental sustainability.

A brief to the Prime Minister's Caucus Task Force on Future Opportunities in Farming

Canadian Institute for Environmental Law and Policy (CIELAP)
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Executive Summary

CIELAP believes that encouraging adoption of genetic engineering technologies is not a prudent approach to improving the long term financial and environmental sustainability of the agriculture sector. As evidenced in current crop and food applications, GE crops will not lead to improvements in farm income because they are not increasing yields or reducing input use and costs in aggregate. Markets are also threatened, in part because segregation of non-GE from GE crops is likely impossible at tolerance levels acceptable to international buyers. Improvements in environmental performance will not result from GE crop adoption. In fact, environmental performance will likely decline since reliance on pesticides is not going down. Negative impacts of GE crops on beneficial organisms are now regularly reported in the independent scientific literature. Consumer confidence will not be buoyed since GE crops and foods are highly, and legitimately, controversial.   In our view, governments should be investing in other strategies, such as Integrated Pest Management (IPM) and organic farming, if they want to secure a viable future for Canadian farmers.

Introduction

CIELAP has been evaluating GE crop and food applications and the Canadian regulatory system since 1985. We believe that Canadian agriculture will be poorly served if genetically engineered crops and foods are a key component of Canada's agricultural future. In this brief, we focus on 4 key and related problems, relevant to the mandate of the Caucus Task Force, that are created by reliance on genetically engineered crops and foods as an agricultural production and marketing strategy:

- no improvements in farm income
- reductions in environmental performance
- difficulties establishing effective Identify Preserved (IP) tracking and tracing schemes
- reduced consumer confidence in the food supply

We then lay out the case for promotion of organic farming as a strategy that solves multiple problems in agriculture, including low income, environmental degradation, and low consumer confidence.

Current GE crop applications will not improve aggregate farm income

Farm income can be improved with:

- yield increases at low additional cost and no associated reductions in market prices
- input cost reductions without significant yield declines
- greater resilience to market and climate variability
- strategic alliances in a commodity chain that provide assured access to markets
- new markets with customers willing to pay premium prices, especially if growers meet quality expectations of customers and can assure the authenticity of the their quality claim

For most farmers, current GE crop and food applications will not provide any of these opportunities.

<u>No consistent yield increases</u>

Increased crop yields are supposed to be one of the major social benefits of this new technology. But claims of higher yields have not been realized across the board, varying by region, commodity and study. Not much Canadian data are available, but based on data from US state varietal trials, RR soybean yields in the US are usually 5-10% lower than comparable non-GE varieties in comparable tillage systems. The likely causes are the gene itself or the gene insertion process which may be disrupting metabolic activity in the plant, and possibly reduced nitrogen fixation and increased disease pressure associated with glyphosate application[1]. Yields of Bt corn have been very variable by US region[2]. Two studies on canola produced conflicting results: one identified no consistent yield advantage for GE canola[3], the other did[4]. From evidence to date, the consistent theme is that GE crops only outperform conventional varieties under particularly circumstances (e.g., for Bt corn, under conditions of high European Corn Borer pressure).

Even if yields were increasing, given that corn, soybeans and canola are all bulk commodities very subject to price fluctuations based on supply, and given current low prices, increased yields would likely just result in reduced prices. This possibility has not been well studied by GE proponents and government analysts.

<u>No consistent input reductions</u>

GE crops are also not producing the input cost reductions that proponents claimed the technology would bring. GE crops are expensive relative to traditional varieties. When the technology use agreement is included, they can cost several times regular seed prices, and farmers who buy them are forbidden from saving and replanting seed the following year. Should GE wheats be commercialized, this will be an acute problem for wheat farmers. Wheat is one of the few major crops in North America that has yet to be hybridized in a significantly commercial way[5]. Consequently, growers are able to save seeds and plant them in subsequent years. Assuming GE wheat varieties are subject to some form of technology use agreement or equivalent, then annual seed saving will be lost as an option. Even growers who do not use GE wheats will be affected because the need for segregation will require that all growers use certified seed every year (not bin run), something that only 20% do currently[6]. This will have significant seed cost implications.

Proponents of genetic engineering have claimed that farmers will not have to spray their crops as much with herbicides and insecticides. Many individual farmers believe that GE crops have reduced their pesticide use, but when all farms using this technology are taken into account the story is far less positive. On average, there is no consistent pesticide reduction in crops[7]. At best it can be said that pesticide reduction occurs under specific circumstances with specific crops in specific regions. For example, Bt corn technology appears to result in lower pesticide use to control European Corn Borer (ECB) in parts of Ontario, where ECB pest pressures are present at least 1 year in 3, but it does not provide such a result in much of the United States where spraying for ECB control has actually increased[8]. The story so far on HT crops shows that reliance on herbicides is not, on average, declining. Growers become more dependent on herbicides like glyphosate and may actually increase their treatments as a result. They find Roundup Ready crops convenient, since glyphosate is a convenient product to use and the timing of its application often works well with other operations. As well, glyphosate is cheaper than many other herbicides, so herbicide costs may decline. This does not discount the fact, however, that herbicide use is up in RR canola[9] and RR soybeans. A detailed analysis of herbicide use on conventional and RR soybean acres shows that RR soybean systems (and the associated herbicide price wars triggered by the technology's introduction) are encouraging farmers to move away from low-input sustainable soybean systems in favour of those more dependent on herbicides[10]. One analyst calculates that pesticide use in RR soybeans is 5-10 times higher than in advanced Integrated Pest Management (IPM) systems[11].

<u>The cost of volunteer GE crops</u>

As well, no studies have yet to account for the economic costs of GE crop volunteers. The farmers who have to deal with the potential problems are very concerned about how to manage them[12] and expect them to regularly pose problems with a price tag, likely several dollars / ac[13]. Volunteer canola plants resistant to one, two or three herbicide tolerant traits at the same time have already been found[14]. Dealing with RR canola volunteers requires, relative to conventional canola volunteers, that glyphosate spray tanks be spiked with additional products. Using tank mixes was already underway because of weeds glyphosate did not control well, but RR canola volunteers have made it a requirement. Spiking does not necessarily result in reductions in glyphosate application since many farmers are finding that weed tolerance is increasing the rates that must be applied to be effective. As well, the product used with glyphosate can limit rotational options. For example, 2,4-D is probably the most popular option because it is cheap and effective against broadleaf weeds and volunteer RR canola. But if it is applied pre-planting as a burndown, the herbicide residue on the surface can have a negative impact on broadleaf crops planned for the next phase of the rotation. If the timing and moisture conditions are not optimal, growers may be forced to grow a cereal crop like wheat which is not affected by 2,4-D residue. Or, growers may have to use a more expensive and possibly less effective herbicide in the mix with glyphosate[15]. All this complicates management, particularly if the rotation has to be changed, since rotational changes may have other environmental implications, including managing nutrients and diseases.

Volunteer wheat is very competitive in canola, even more so than wild oats on a per plant basis, can sprout up to 6 years after planting, and may cause serious yield losses[16]. Volunteer RR wheat will not be controllable in canola with Roundup, an herbicide that works against conventional volunteer wheat. Other, generally more expensive, herbicides will be required in the tank mix, the same ones that are already causing weed resistance problems[17]. All together, this will make weed management more complicated and may result in increased herbicide spraying, a result that would contradict the expressed purpose for developing the technology. Dr. Hartley Furtan, professor of Agricultural Economics at the University of Saskatchewan, is completing a report on the farm economics of herbicide tolerant wheat. He suggests that any possible weed control benefits of RR canola could be lost when followed by RR wheat. He has stated, "Then you're going to have to use a more complex herbicide cocktail .... There will be increased costs in the second crop, which reduces the total benefits."[18] The Canola Council study that reported yield and input cost reductions[19] did not account for the added costs of managing volunteer RR canola since the work was done largely before RR canola volunteers emerged as a significant problem.

Loss of markets

Canadian farmers are losing export markets because of GE. Canadian canola exports to Europe are down (and Australian exports up) because of GE canola. Chinese importers are interested in Canadian canola because of its low price, but no deals have been arranged because GE crop importing rules have yet to be sorted out[20]. The Canadian Wheat Board is predicting that 60% of its wheat markets will not accept GE varieties. In contrast to the plight of GE crop producers, many food-grade soybean growers are finding they can extract a market premium by assuring customers their crops are not GE varieties.

Convenience rather than profitability

Given, for many farmers, no yield increases, increased seed costs, no reductions in pesticide input costs, and loss of markets, GE crops are proving to be less profitable than many conventional varieties, and perform particularly poorly when compared with low-input systems. An emerging theory amongst economists is that GE technology is adopted primarily for its convenience[21], and it may be a short-lived convenience if gene transfer continues in some crops, if volunteer management continues to be problematic, or if pesticide resistance expands to a wider range of pests.

Environmental problems will rise, not decline, because of GE crops

The emerging evidence is that GE crops are having significant and subtle negative environmental impacts, instead of generating environmental improvements. The previous section identified how the current applications are not leading to pesticide reductions as claimed.
There are also now reports of negative impacts on non-target organisms. Several studies indicate that populations of bees, lacewings, ladybugs, monarch butterflies, and soil organisms may be reduced by exposure to GE crops[22].

Harm to lacewings and ladybugs is of particular significance from a pesticide use perspective since reducing the populations of beneficial insects means reduced levels of natural pest control. Research conducted at the Swiss Federal Research Station for Agroecology and Agriculture found that green lacewings, an important predator of many agricultural pests, experienced retarded development and 67 per cent greater immature mortality when reared on European corn borer s (ECB) fed Bt corn as compared to non-Bt fed ECB[23]. Further studies confirmed the direct toxicity of the Bt toxin expressed in transgenic corn to lacewings. Insects fed the Bt diet had almost double the mortality levels (57%) of those fed the non-Bt diet (30%)[24] .

Researchers from the Scottish Crop Research Institute found that female ladybugs that ate aphids fed on genetically modified potatoes laid fewer eggs and lived only half as long as ladybugs feeding on aphids which ate non-GE potatoes[25]. The potatoes were genetically engineered to include a toxin found in snowdrops – GNA lectin – which kills potato aphids. These same GNA lectins are being used in GE experiments with grapes, canola, rice, sweet potato, sugar cane, sunflower, tobacco, walnuts and tomato. While the transgenic potatoes suffered reduced attacks, reductions were insufficient to compensate for the decreased aphid control performed by ladybugs feeding on the green peach aphid (*Myrzus persicae*).

Researchers also found that up to 30 per cent fewer viable eggs were laid when one of the parent ladybugs was fed aphids from lectin-transformed potatoes. This is significant because ladybugs prey on a wide variety of aphids that are serious pests in corn, alfalfa, canola, wheat, flax, peas, apples and potatoes. A single ladybug larvae can eat 800-1000 aphids before pupating and an adult can eat 3000-4000 during its lifetime[26]. Reducing such beneficial insect populations means more difficulty controlling aphids, and greater likelihood of spraying.

These problems mean, paradoxically, that GE crops will actually create new environmental (and agronomic) challenges rather than reducing them as claimed by proponents.

GE crops will compromise Identity Preserved (IP) tracking and tracing

Much of the current discussion of new economic opportunities for farmers focuses on providing customers with their requested quality attributes and the IP tracking and tracing systems required to provide that assurance. Current GE crop applications will make establishing IP systems more complicated. The current GE crops are bulk commodities, not niche markets, so current IP tracking and tracing technology is incapable of ensuring segregation of these high volume bulk GE commodities from their non-GE analogs at tolerances likely to be acceptable to international markets. GE crops are proving to be so difficult to control and segregate that other IP systems designed to guarantee non-GMO status will be hard pressed to meet their claim. As bulk commodities, GE crops are not attracting premium prices, so no incentive exists for GE crop IP systems.

Canola is the best current example of this problem, and GE wheat would be a future one if fully commercialized. Given the dispersal of GE canola across the Prairies, resulting from gene flow, weather-related dispersal, and handling and transport contamination, it is now highly unlikely that non-GE canola certified seed can be acquired at acceptable tolerances. If the seed quality cannot be verified, there is no non-GE canola market. Saskatchewan organic farmers are the first to recognize this problem because the organic canola market has been now been effectively destroyed by GE canola contamination. They are preparing to sue Monsanto, and likely the federal government, in early 2002 as a result[27].

If unconfined release is granted, GE wheat, although more a selfer than canola, will still contaminate non-GE wheat through outcrossing due to the sheer number of GE wheat plants that could potentially populate the landscape. Trucking and handling will also be significant sources of contamination. Huge volumes of wheat are stored in elevators and bins according to varieties and classes in order to serve specific markets. The wheat handling system has relied historically on visual identification of wheats to minimize contamination and preserve the distinct identities of the various wheat classes. All this will be in question once GE wheats are introduced since there will be no way to visually distinguish GE varieties from their conventional analogs. The current handling infrastructure is too complex to segregate GE wheats without significant human errors. Many in the wheat trade question whether segregation is achievable below 2% contamination tolerances. Consequently, some international buyers are saying they will avoid Canada entirely as a source of wheat.

In our view, establishing IP tracing and tracking systems that work will be virtually impossible in any commodity that has a bulk GE market. This means there will not be much potential for grower premiums and assured markets in these commodities. Even more significantly, many buyers may simply avoid Canadian markets all together rather than attempt to verify any claims made about the quality of our IP systems.

GE undermines consumer confidence in the food supply

The food and agriculture sector is now haunted by its use of controversial practices, products and technologies. These controversies are not artificially constructed. There are scientific data to support a conclusion that there is something controversial going on. The controversies result from approaches to problem solving that temporarily solve one problem, and generate new ones that require additional technologies to fix[28]. The consuming public, though generally unable to articulate this process, is tired of the result - human and environmental health risks borne by people and organisms that did generate the risk in the first place.

GE crops are no exception to this unfortunate pattern of technological development in agriculture. It is precisely because agriculture repeats this pattern year after year that no amount of consumer education will overcome resistance to the technology. The idea that, because surveys show most consumers are not that informed about the technology, consumer information campaigns will generate successful market acceptance is simply naive. In particular, the bulk commodity sectors - from whence most current GE applications arise - are the slowest to absorb this reality because they are typically the furthest from the final consumer. These sectors do not understand the complex motivations that drive consumer food behaviour. Consequently, allowing GE crops to be part of our agricultural future will undermine the very consumer confidence that policy makers wish to generate.

Other approaches that are consistent with the framework

There are several farming system approaches that are will improve the financial and environmental sustainability of Canadian agriculture. The one, though, that consistently receives little attention from policy makers is organic farming so we elaborate on it here.

Improves environmental performance

A UK study of the real costs of the British food basket estimates that the external costs of organic farming are one third those of conventional agriculture[29], so investing in organic farming is a good pollution abatement and remediation strategy. As an example of such investing, a Swiss study concluded that it was cheaper to pay conversion subsidies to all the farmers surrounding a lake, than to pay for a technological solution to clean up the lake.[30] It is well established in North American literature that the off-farm benefits of mitigating soil and watercourse degradation far exceed the on-farm costs of soil conservation[31]. Organic farming is well known for its soil conservation benefits, and the costs of this conservation are internalized by organic farmers.

From a systems perspective, organic farming usually leads to reductions in greenhouse gas emissions. These farms are generally characterized by complex cropping patterns, with significant use of green manures, intercrops and legumes and reduced reliance on synthetic pesticides and fertilizers, reduced tillage, deep and extensive root masses, and high soil organic matter levels, and good soil tilth. Liquid manure is rarely used in organic livestock systems, and since organic farmers rely on manure as a fertilizer source, there is greater emphasis on minimizing nutrient losses. Animal stocking densities are generally lower. And, as discussed below, these systems are generally more profitable for farmers, partly due to lower input costs, and partly because consumers are interested in paying premiums for such products.

There is some empirical research on sustainable farming systems that demonstrates greenhouse gas emission reductions, greater adaptive capacity in the face of climate variability and significant carbon sequestration potential. For example, a study carried out for the federal German parliament came to the following conclusions when comparing conventional and organic farming systems[32]:

- The organic systems used 65% less energy than the conventional ones. The main differences in fossil fuel consumption were associated with the “operating materials”, synthetics pesticides and fertilizers and imported feedstuffs.
- Although conventional operations fixed more carbon in shoots and harvested main crops, the organic systems tended to have much higher root masses. Roots in organic systems had 1.6 times more bound carbon dioxide, most of it associated with legume crops such as alfalfa and red clover). When all biomass generated in ecological systems is contrasted with conventional ones, the above ground production is similar.
- Ecological systems generally have more active soil microflora and detectable increases in the assimilation of carbon dioxide, whereas conventional systems have less carbon dioxide bound up in soil organic matter.

Drinkwater et al. in their study contrasting conventional and alternative corn - soybean cropping systems in Pennsylvania, found that longer rotations involving leguminous plants did not necessarily add more total organic matter to the soil, but because of the lower carbon to nitrogen ratio additions resulted in greater organic carbon sequestration and improved soil physical properties[33]. As well, they cut nitrogen losses in half compared to conventional system.

Increases consumer confidence

Organic farming and food processing standards[34] do not permit a number of products and practices perceived to be risky by many consumers:

- Synthetically compounded pesticides - almost all pesticides believed to have potentially negative health impacts on humans are not permitted in organic production. Consequently, residues of production pesticides are almost always lower in organic foods[35]. However, organic farmers are unable to control atmospheric deposition of airborne pollutants; consequently, organic food is not residue free[36].
- Fertilization - in contrast to conventional farmers, organic farmers are not permitted to use uncomposted manure, except under very specific circumstances. The composting process reduces pathogen levels and leaching of nutrients.
- Animal rearing practices - growth hormones are not permitted, and animals must be a fed a diet for which their digestive system is adapted. Consequently, the digestive conditions associated with elevated E. coli 0157:H7 levels do not normally occur on organic farms[37]. Mycotoxin levels in animal feeds are no higher than in conventional agriculture, and some European studies have found lower levels in organic than conventional milk[38]. Standards do not permit the use of antibiotics, unless the life of the animal is in jeopardy. Most standards then require that the animal be removed from the organic stream, although some permit its return following an extended withdrawal period. As a result, it is not possible for production practices to create antibiotic resistant bacteria.
- Synthetic preservatives and additives, and irradiation - the use of synthetic preservatives and additives is severely restricted, largely to materials derived from naturally occurring substances. Food irradiation is not permitted.
- Genetically engineered organisms and products derived from them - these are not permitted in organic farming or food processing, except in cases where no organic sources exist, and conventional ones may be inadvertently contaminated.

<u>Increases farm profitability</u>

That organic agriculture systems are usually more profitable than conventional is not widely appreciated by policy makers.

In organic systems, from worldwide evaluations:[39]

- Plant yields are on average 10% below and animal product yields on average 20% below conventional systems.[40] These results have occurred almost entirely without the support of institutions normally involved in agricultural development. Yields in organic systems continue to rise as understanding of them grows and as more money is devoted to research. These increases are not always as great as those under some conventional systems, but occur at much lower environmental costs.[41]
- Gross margins are at least as good, if not better than, systems under conventional pesticide regimes. Three factors usually account for these positive income results. First, operating costs may be up to one third lower, particularly for energy, chemicals, and drugs. Second, where premium prices are available, the likelihood of a superior net income situation is even greater. Finally, many organic farmers achieve higher net income by making more direct links with consumers which allows them to capture a greater percentage of the consumer dollar.[42]

Such economic benefits have significant implications for governments. Although a good safety net system is important, governments should help to create the conditions to improve farm financial health and lower financial risks. Organic farming can create these conditions. They are at least as, if not more, profitable than conventional systems as well as less vulnerable to climate variability.[43] In general, they have a greater capacity to resist both wet and dry conditions. This occurs because these systems rely on building soil organic matter levels to ensure optimum health for crops and greater pest resistance. The side benefit is both greater moisture retention capacity during dry years and better soil tilth for improved drainage during wet ones. As well, these systems tend to be more diverse, providing more revenue streams. Reduced yields or revenues in one crop/product are less likely to penalize the operation as dramatically as in systems where financial health is dependent on a limited number of crops. Overall, these farming systems are less likely than many conventional farms to suffer yield and revenue losses that would trigger safety net payments.[44]

<u>GE crops are compromising the adoption of organic farming</u>

In our view, organic farming is a very important system to promote yet GE crops threaten to eliminate some organic crops from the landscape. Organic canola is already lost due to widespread GE canola contamination of the seed supply. Organic wheat production, and the crop rotations that depend on it, will also be seriously curtailed if GE wheat is commercialized. These threats have inspired the recently announced class action lawsuit by the Saskatchewan Organic Directorate, with Monsanto and the federal government the likely named parties in the suit[45].

Concluding remarks

We view the way the Prime Minister's Caucus Task Force on Future Opportunities in Farming approaches GE crops and foods as a litmus test of your real commitment to creating a finanicially and environmentally sustainable agriculture in Canada. The evidence suggests a minimal role for GE crops and foods. Should GE crops and foods be a central thrust of your recommendations, this will demonstrate to us that governments and elected officials in Canada have an idealogical commitment to GE that is not supported by the data.

Endnotes

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